

The Summer Undergraduate Research Fellowship (SURF) Symposium  
3 August 2017  
Purdue University, West Lafayette, Indiana, USA

# Gas-based Perfusion fMRI Cerebrovascular Reactivity Maps and Time of Arrival Maps

---

Jinxia Yao  
Agricultural and Biological Engineering, Purdue University  
Matthew R. Derdark and Yunjie Tong  
Weldon School of Biomedical Engineering, Purdue University

## ABSTRACT

Perfusion MRI is a promising tool used in assessing stroke, brain tumors, and patients with neurodegenerative diseases. However, common perfusion MRI techniques have several disadvantages, such as using exogenous contrast agents, low signal-to-noise ratio and long acquisition time. In this study, we used a computer-controlled gas delivery system RespirAct TM. This system provides a reliable carbon dioxide based vasoactive stimulus. This stimulus will immediately generate large and reliable functional magnetic resonance imaging (fMRI) signals, which can be used for perfusion imaging. Each subject was required to have three sequential magnetic resonance imaging (MRI) scans, which are structural scan, resting state fMRI scan while breathing room air, and fMRI scan while breathing a sequence of gases. Crucial perfusion parameters such as cerebrovascular reactivity (CVR) maps and time of arrival (TOA) maps were derived. CVR is defined as the change in cerebral blood flow in response to vasoactive stimuli. TOA maps reflect the blood arrival time at each voxel. It has been demonstrated that many cerebral vascular diseases can alter the CVR and TOA maps. By using accurate gas delivery system in perfusion MRI study, accurate CVR and TOA maps are derived, which will be applied for the early detection and diagnosis of various brain diseases.

## KEYWORDS

Cerebrovascular reactivity, time of arrival map, functional magnetic resonance imaging (fMRI), blood oxygen-level dependent (BOLD) signal, carbon dioxide